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A Blue Revolution: The Global Crisis of Water Quality and Accessibility

Sasha Nicole Kruger
College of DuPage

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by Sasha Nicole Kruger

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Abstract

Water quality and safety is a persisting international health crisis that concerns not only developing, marginalized countries, but continues to affect nations and regions throughout the world. As a resource essential for the biological processes of cellular life, water shortages and contamination have created devastation in the health of human populations around the globe. Water-borne illnesses and enteric diseases remain the most concerning results of contaminated water supplies and lack of sanitation systems. This paper explores global water quality and its effects on human health, while providing urgent solutions for this epidemic and its deficient system.

An Indispensable Resource

Water is a fundamental, and yet, ironically, scarce requirement imperative to human existence (Massoud et al. 2010). Comprising over 71% of our Earth's surface, 70% of our tissues, and 55% of our blood, fresh, clean water sustains the ecological balance essential for planetary health and vitality (Black 2004). Nevertheless, Earth's potable drinking water is less than 1% of the total 71% of water covering Earth's surface (Mahaya et al. 2009). Water, also known as the universal solvent, is central to facilitating the biological processes necessary for human life; therefore, the degradation of our planet's water supply, and subsequently the hydrological cycle, will eliminate life faster than any nuclear arsenal (Black 2004). Accordingly, safe, available drinking water is significant in the maintenance of humanity and our environment, within an array of contexts (Massoud et al. 2010).

Water's function and impact on establishing food security, promoting poverty reduction and economic growth, and preserving ecosystem biodiversity for generations to come is extensive (Anand 2006, Massoud et al. 2010). Water's priceless position within our environmental community makes it an especially critical resource to our global health; unsuccessful attempts to supply accessible and safe drinking water places a heavy burden upon populations internationally. Although the last century has observed increases in industrial development and prosperity globally, human populations are still struggling to attain the most basic of human needs: food resources, shelter, clean drinking water, and access to sanitation systems (Massoud et al. 2010). The inextricable associations between poverty and accessibility to uncontaminated drinking water include, but are not limited to, elevated productivity due to enhanced health, more time augmented for constructive use, gains in well-being through decreased morbidity and mortality rates, advantages of water usage in revenue-earning activities thus advancing water's potential in community development, and diminished spending on healthcare and medical resources (Harvey 2008).

The evidence of a positive association between the proportion of global populations with access to reliable and adequate water and sanitation systems and the human development index demonstrates that health benefits due to clean water are not the only arguments for improving sanitation services and water supplies (Anand 2006). The Humanitarian Charter, as well as a number of legal and institutional forums, defines water as a basic human right; therefore, providing access to safe water reservoirs through sustainable services has the ability to promote justice and the empowerment of communities worldwide (Harvey 2008).

Water is the third largest industry after oil and energy and, as a result, it is treated as both an

economic and public good. Although the provision of clean water supplies, in addition to adequate sanitation services, are essential to the fitness and advancement of human development and growth, at present, millions of people are deprived access to both (Marella 2010). As human populations continue to expand rapidly, awareness of the concerns surrounding international water quality has amplified as the necessity of resource conservation for future generations becomes apparent (Mahaya et al. 2010). Consequently, it is imperative to examine why improving safe access to clean water and modes of waste disposal are so problematic, and to what ways can institutions and policies produce progress in sanitation and water-management renovation, including its wide spread provision (Anand 2006).

A Crisis of Contamination

Insufficient quality and quantity of clean, potable, drinking water is threatening today's human populations and environmental biodiversity worldwide (Mahaya et al. 2009). Water quality has been quickly dwindling in economically marginalized nations; more than two million people die each year from waterborne diseases, and of these fatalities, 88% can be traced to contaminated water resources, lack of effective hygienic practices, and inadequate (or absent) sanitation facilities (Mahaya et al. 2009, Peter 2010). Around 19.5 million waterborne illnesses transpire in the United States alone each year, and of the 76% documented, approximately 33% are ascribed to tainted groundwater systems (Charrois 2010). With only a small portion of Earth's compositional surface water acceptable for use, our global water predicaments have been compounded infinitely. Natural droughts and other climatic phenomena are increasing in incidence due to global warming and, as a result, are exacerbating present and future water-related dilemmas (Mahaya et al. 2009). Floods, too, bear the perils of increased frequency in dysentery cholera, diarrhea, malaria, other associated illnesses and their costs; as pit latrines overflow, contaminated water stagnates for days, creating the most conducive environment for disease. This mismanagement of water supplies and the contamination of current water resources are cause for further devastation, as local water sources are inextricably linked to the quality of the global water supply (Mahaya et al. 2010).

Biological pollution and chemical contamination arise from a variety of origins including the catchment areas, during collection, in storage, or through distribution of water reserves (Massoud et al. 2010). Waterborne illnesses, whether communicable (induced by pathogens) or noninfectious (produced by toxic chemicals), and chemical contaminants in water, unfavorably affect the health of humans and the entire ecosystem (Charrois 2010, Massoud et al. 2010). Water-related infirmities afflict enormous burdens on both economies and population health worldwide. Every year, nearly four billion incidences of diarrhea occur internationally; on an annual basis, 50% of these cases end in death (Massoud et al. 2010). Sadly, children are the most vulnerable to the risks perpetuated by tainted water resources and unsuitable sanitation facilities. Diarrhea is the leading cause of child mortality (Massoud et al. 2010, Pattanayak et al. 2010). An estimate of 15% of all deaths in children under five are caused by diarrheal infection, yet up to one-half of diarrhea instances could be reduced by safe water provision and sufficient waste-management services (Massoud et al. 2010, Pattanayak et al. 2010).

Water pollution is, primarily, microbiologically contaminated due to improper disposal of sewage and wastewater, corroborated by the presence of fecal and total coliform bacteria (Charrois 2010, Massoud et al. 2010). The biggest hazards attributed to the safety of domestically used water are microbial contamination. The pathogenic organisms adept in generating waterborne diseases include enteric viruses (noroviruses, hepatitis A and E), protozoa (*Giardia),* and bacteria, such as *E.coli*, Salmonella, and *Shigella* (Charrois 2010). Outbreaks of water-related illnesses can be provoked by weather, such as spring runoff or heavy rainfall, seeping sewage from water treatment systems, leaking septic tanks, cesspools, landfills and sewer runoff, insufficient awareness of sanitation conditions in wells, and inadequate land-waste disposal methods of manure (Charrois

2010). Sullied and unhygienic pits employed for waste disposal, absence of any disinfection method or sewage facility, lack of maintenance if at all an operation, and the deterioration of pipeline networks also contribute to water pollution (Eisenberg et al. 2010, Massoud et al. 2010).

Natural and anthropogenic activities are increasingly affecting potable water sources as well (Massoud et al. 2010). Accelerated population growth in some areas requiring simultaneous infrastructure development has created water shortages, particularly in marginalized, developing countries (Massoud et al. 2010). Political instability, legislative and economic constraints, the fragility of administrative infrastructures, and insecurity throughout regions across the globe, have also led to deficient water development plans, systems, and services (Anand 2006, Charrois 2010).

The common impression that private water networks, the bulk of which uses groundwater from rural areas, generate superior water quality compared to public systems is baseless and unsubstantiated (Charrois 2010). Groundwater is the principal supply of drinking water for communities, as well as for irrigation. It is being used more frequently due to heightened global demand for safe, clean water sources, in addition to increased drought incidences and contamination of surface water having minimized the availability of pure drinking water (Vigil 2003). Inconvenience and lack of time are the most chronicled impediments attested to regular testing in private wells and water systems; this poses a great risk to the health of populations around the globe, as water quality is not unsusceptible, nor unchanging (Charrois et al. 2010). According to a study performed in a rural karst system providing drinking water in the Northwest of France, the transport of *E.coli* from the creek to a water well were both isolated from animal and human origin, indicating water resources taken from groundwater terrain are notably vulnerable to antibiotic-resistant bacteria (Laroche et al. 2010).

Closer to home, the West Branch of the DuPage river is, too, a site for contaminated sediments, banks, and floodplains. In 1967, radioactive thorium was leached from a nearby facility, then carried by a storm sewer to a nearby creek, and subsequently traveled downstream through the West Branch of DuPage River. Since February 11th, 1991, the West Branch of DuPage River has been federally noted as one of four *National Priorities List* sites regulated by the EPA in the western suburbs. Non-communicable illnesses, originating from elemental contamination, are also concerns for the ecological and biological health of communities. The cleanup of DuPage River, approximated to cost 71.9 million dollars, clearly illustrates that the socioeconomic price of inattention to our actions greatly outweighs the inconvenience (National Priorities List 2010).

Rural populations frequently lack access to treated tap water, and as a result, rely on lakes, streams, and natural springs for the majority of their domestic water use (Mahaya et al. 2009). The WHO/UNICEF joint monitoring program approximates around 1.1 billion people who have no accessible means to adequate drinking water, and twice that amount lack basic waste management systems (Mahaya et al. 2009). Over 80% of all contagious diseases are dispensed through drinking water that has been polluted either at its source or during distribution and storage (Mahaya et al. 2009). Such statistics illustrate why the international health burdens of hygiene-related illnesses and water-sanitation afflictions remain persistent (Eisenberg et al. 2010).

Challenges to Water Security

Political contentions have led to considerable obstacles in procuring clean, safe, drinking water, as economic and political considerations are inclined to influence and coerce water and sanitation strategies and policies (Marella 2010, Massoud et al. 2010). The last few decades have witnessed the privatization and commoditization of water, an indispensable good vital for human life and development. Large-scale, intercontinental corporations accrue water as facilitators of access to water, as suppliers of water, and as consumers of water (Marella 2010).

On a global scale, public water is inexpensive compared to privately owned water supplies, so most households in villages use the public systems out of necessity (Massoud et al. 2010). Water

shortages have also become community-wide issues for water scarcity due to physical and commercial use, deteriorating water systems with minute maintenance, and illegal linkage are not addressed challenges within the water deficit (Massoud et al. 2010). Rural regions' primary contentions to providing safe and sustainable access to potable water are that they often suffer deficient healthcare services, lack adequate nutrition and public education, and are comprised of unstable infrastructure with low-income levels (Massoud et al. 2010). Accordingly, these municipalities urgently require clean water supplies.

The challenges of wastewater removal for large cities in developing countries are compounded, owing to limitations of technology, investments, lack of any supervision or testing parameters, and governmental operations; thus, engaging communities in projects to develop new, innovative technologies is of great value (Anand 2006). However, the choice of technology may infringe upon the livelihood and communal identity of certain cultural and social groups (Anand 2006). A case study done by Oregon State University observed the acceptance of solar disinfection of drinking and domestic water supplies in a village in Kathmandu Valley, Nepal. Recognizing the milieu of water purity, as a concept and in its context, was crucial to determining socially appropriate inventions for the enhancement of potable water sources, thus directly affecting community health. Participants were doubtful about the necessity of treating drinking water, and the lack of knowledge that consuming untreated water causes diarrhea hindered the success of proliferation of a new technology into their society. It is necessary for further approaches, in constructing safe water networks, to provide education and promote awareness about water-related illnesses and diseases; in addition, subsequent stratagems should offer a motivational component that best match the needs and capabilities of the community, encouraging implementation and continued use (Rainey and Harding 2005).

The Rural Water Supply Programme of Tanzania in Mount Kilimanjaro assured rural communities that they would supply clean and safe drinking water to their expanding populations; however, their pipeline network challenged a centuries-old system of water furrows and the clan-based societies that supervised them. The program threatened to diminish the cooperation and control of the communities towards their water reserves, and accordingly, members became less willing to provide physical and financial contributions. The program's accomplishments, or lack thereof, were due more to how community members chose to interpret and utilize the system, rather than that of the municipality itself (Bender 2008).

Chemical pollution of potable groundwater reservoirs commonly provides abundant levels of naturally occurring metals such as arsenic, selenium, nitrate, and lead, all high-risk health parameters (Charrois 2010). Pesticides are distributed in agricultural areas and contaminate water supplies due to the runoff from these crop fields (Massoud et al. 2010). Investigations supervising pesticides and analysis of these inorganic contaminants are expensive, making the development of monitoring programs and their widespread provision difficult (Anand 2006, Charrois 2010). The supervision and jurisdiction of water quality usually lies with municipalities responsible for environmental or health related parameters, depending upon region or nation. However, persistent neglect to water quality and its care is evident when it comes to ensuring that regulation standards for public and private water networks are up to par (Anand 2006, Charrois 2010).

Policies regarding sustainability and health must concern the allocation and use of all natural resources, as all communities are responsible for their impacts on global resources and international water supplies; this is especially apparent in the mismanagement of potable water sources in developing countries, where water provision and consumption are in disagreement with the objectives of sustainable development (Anand 2006). For instance, building dams to provide electricity and water to metropolitan areas can affect the ecological functions of rivers. The environmental affects of water activities are further aggravated due to inadequate water systems and unreliable sanitation disposal methods. To expect the developing world to attend to the requirements

of future generations when the critical needs of the present era are not being met is illogical and unreasonable (Anand 2006).

Innovations and Solutions

The difficulties and deterrents towards creating clean and affordable drinking water can be conquered through proper planning and appropriate, reliable procedures (Massoud et al. 2010). Water and sanitation system renovation appears expensive, but reducing water shortages and increasing clean water supplies will be cost-effective, economically and socially, in the long-term (Massoud et al. 2010). Fresh water reserves, in addition to community engagement in resource conservation activites, are imperative to diminishing water loss, implementing sustainability, and enhancing the health of global populations. Restrictions due to the limited domestic and fiscal supplies within developing nations necessitate the development of new and improved economic methods of investment. Operation schemes for management of clean drinking water should be based on a multidisciplinary evaluation of the environmental, technical, educational, economical, and social facets of the community (Massoud et al. 2010).

With unemployment, political instability, and poverty as highly realized circumstances of rural countries and their communities, lack of incentives and finance cannot incite the development of environmental monitoring programs, nor encourage their optimal performance; therefore, a consistent, institutional framework, with clear standards and quantitative objectives for decision-making, must be created (Anand 2006, Massoud et al. 2010). Supplying information on the use, availability, and the quality of water, as well as the regular monitoring of residual chlorine and fecal bacteria concentration in the water distribution system, is crucial to an effective system (Eisenberg et al. 2007, Massoud et al. 2010). These municipalities need to carry out systematic testing, as the efficacy of sustaining consistently clean water resources will depend on the level of regularity. Successful, although simple, regulations can be taken to protect present water supplies and prevent the accruement and dispersal of pollutants (Charrois 2010, Massoud et al. 2010).

Educational material must also be supplied about the quality of drinking water, the risks of water pollution, how to safe-guard water reservoirs from contamination, and providing awareness to simple hygienic practices, as this could empower local communities to protect themselves against communicable and infectious pathogens, thus reducing water-related infirmities (Massoud et al. 2010). Encouraging public awareness of the persisting financial and ecological health benefits of water maintenance and preservation can change and shape the behaviors and, consequently, the health of communities (Anand 2006, Massoud et al. 2010). Providing local people with a multitude of resources, education, and information essential to enlightening the community about environmental and health issues that directly affect them is the only way to cooperatively institute a comprehensive and safe drinking water system (Massoud et al. 2010). A program driven by community demand, however, would be the most effective, as households are willing and able to access the improved services, revolutionizing the health of their community directly (Pattanayak et al. 2010).

Solar water pasteurization is a possible solution to a low-cost disinfection method for economically marginalized nations, where the constraints of fuel and cost prevent people from boiling contaminated drinking water. Electromagnetic radiation from the sun disinfects the water as the sun's ultraviolet radiation inactivates microbes, without having to reach a boiling point to accomplish disinfection (Mahaya et al. 2009).

The disparities of public health surveillance in rural areas can be attributed to inconsistent and deficient water testing parameters and absence of any evidence-based research on water security (Charrois 2010). The youth of today are citizens of the future, and as a result, the awareness of their abilities to execute and encourage sustainable habits for future generations must be realized before these predicaments escalate (Mahaya et al. 2009). Our younger generations need to become citizens-

of-the-world and assume the responsibilities of taking care of the larger community in which we are all a part of: Earth.

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